

REMARKS

By the present amendment, claims 1 to 22 are pending in the application.

Support For Amendments

In independent claims 1, 2, 8, 9 and 10, support for the new claim limitation -- and having a microstructure composed of degenerate upper bainite of more than 70%-- may be found in the specification at page 16, lines 18 to 21. The specification discloses at page 16, lines 18 to 21 that if degenerate upper bainite in the microstructure exceeds approximately 70%, the ratio $(Hv - avep)/(Hv-M)$ is in the range between 0.8 and 0.9 as claimed in the claims.

In the independent claims, the composition of the steel has been defined by the phrase --consisting essentially of-- instead of "consisting of". Note that dependent claims 3, 11 and 17 add N to the composition of independent claims 1, 9 and 15 respectively.

§103

Claims 1 to 22 were rejected under 35 U.S.C. §103(a) as being unpatentable over Canadian Patent No. 2,429,439.

This rejection, as applied to the amended claims, is respectfully traversed.

Patentability

Canadian Patent No. 2,429,439 (the " '439 patent")

The technology disclosed in the '439 patent relates to a high strength steel excellent in low temperature toughness and toughness at HAZ, where the steel has a structure composed of bainite and martensite, and contains specific amounts of C, Si, Mn, Ni, Mo, Nb, Ti, V, Cu, Cr, Ca, Mg, REM, and controls the P value to 1.9 to 3.5, and controls a prior austenite grain diameter to not larger than 10 μm .

The '439 patent targets to avoid the formation of coarse grains by means of control of the Nb amount to less than 0.01% (preferably less than 0.009% as shown in the Examples) to secure toughness. Regarding the Nb addition, the '439 patent clearly discloses at page 22, line 33 to page 23, line 10 that

“Nb suppresses the recrystallization of austenite during controlled rolling, makes an austenite structure fine by the precipitation of carbonitride, and also contributes to the improvement of hardenability. In particular, the effect of the improvement of hardenability by the addition of Nb is synergistically enhanced by its coexistence with B. However, if Nb is added to not less than 0.01%, coarse grains are partially generated, thus a percent fracture in an impact test is lowered and weld heat-affected zone toughness is deteriorated when double or more layer welding is applied. Further, in that case, weldability at a site is also deteriorated. For those reasons, the upper limit of an Nb content is set at less than 0.01%. A preferable Nb content is not more than 0.005%.”

On the other hand, the present invention requires a much larger amount of Nb, such as Nb: 0.01 - 0.10%, preferably more than 0.012%, as shown in the Examples, for refining and stabilizing the degenerate upper bainite structure by inhibiting the recrystallization of austenite in controlled rolling. Therefore, the Nb content and object of the addition of Nb according to the present invention is quite different from those of the '439 patent.

Regarding the microstructure, the '439 patent clearly defines that the microstructure is mainly composed of martensite and bainite, and martensite and bainite fraction is defined in the range of 90 to 100%. Page 27, lines 25-34. The '439 patent clearly mentions at page 27, lines 25-30 that “to attain a high strength of not lower than 800 MPa and securing good low temperature toughness, it is necessary to control the amount of bainite, martensite, or a bainite and martensite dominant structure in the range from 90 to 100% in terms of a bainite and martensite fraction”. This means that the microstructure of the '739 patent definitely requires a bainite and martensite fraction of 90 to 100%.

On the other hand, the '439 patent does not disclose or suggest that the microstructure is composed of degenerate upper bainite of more than 70% as an important feature of the present invention. The present invention utilizes degenerate upper bainite for balancing the HAZ portion of the linepipe at the weld site with a longitudinal direction strength of the linepipe mother material, and lowering a longitudinal direction strength against a peripheral direction strength. These effects cannot be attained by the martensite-bainite structure described in the '439 patent.

Further, a bainite structure within a martensite-bainite structure is mainly composed of a lower bainite structure. Generally, when a steel plate is cooled down from austenite region, almost 100 of martensite structure is obtained in case of rapid cooling. On the other hand, when cooling rate is low, a martensite + lower bainite structure is obtained. The lower bainite fraction increases in proportion to lowering cooling rate, and decreasing the martensite fraction. When the cooling rate is further lowered, upper bainite structure generates and then increases such fraction. When the cooling rate is further lowered, degenerate upper bainite generates.

In case of the degenerate upper bainite structure of 70% or more according to the present invention, there is no room to retain the martensite structure in the steel plate. The order of generation of structure is; martensite>lower bainite>upper bainite>degenerate upper bainite in proportion to the cooling speed. Therefore, the martensite + bainite structure defined in the '439 patent means martensite + lower bainite structure, which is quite different from the structure mainly composed of upper bainite structure defined in the present invention.

The Office Action asserted that the steel compositions and a production process defined in the present invention are similar to those of the '439 patent. Therefore, a similar product can be obtained.

However, the present invention defines a cooling of 1 - 10°C/sec. (see method claims), preferably 2 - 8°C/sec., shown in Table 2 after hot rolling for obtaining the upper bainite structure. On the other hand, the '439 patent discloses that a preferable cooling rate after hot rolling is 10 - 40°C/sec. for obtaining martensite + bainite structure, even if claim 14 of the '439 patent defines the cooling rate of more than 1°C/sec. In addition, there is no example in Table 5 at page 42 of the '439 patent where the cooling is carried out with a cooling rate of 1 - 10°C/sec.

Therefore, the '439 patent does not disclose or suggest obtaining an upper bainite structure and a production process according to the present invention. Therefore, the process conditions and the resultant metallic structure according to the present invention are different from the '739 patent.

The Office Action further asserted that Example L in Table 1 of the '439 patent closely meets the claimed composition. However, the metallic structure (upper bainite structure) is different from the present claims. A metallic structure composed of bainite + martensite fraction = 100% is shown in Performance No. 12 (Steel L) in Table 3 is a different metallic structure from the present inventive upper bainite structure. As described at page 34, lines 12 - 19 of the '439 patent, it is understood that a bainite and martensite fraction of 100 means martensite of 100%. Therefore, Steel L of the '439 patent is different from the metallic structure of the present inventive upper bainite structure.


It is therefore submitted that amended claims 1 to 22 are patentable over Canadian Patent No. 2,429,439.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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